IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: BAYER et al. DATE: November 17, 2006

SERIAL NO.: 10/806,026 GROUP ART UNIT: 1713

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FOR: THERMOPLASTIC RAILROAD CROSS-TIES

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DECLARATION UNDER 37 C.F.R. §1.132
TRAVERSING GROUND OF REJECTION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The undersigned hereby declares that he has worked on"Engineered Thermoplasitc Technology" for over seven years. The initial research was conducted at the LSU Chemical Engineering Laboratory in Baton Rouge, LA. Larger profile samples have been produced at plastic extrusion plant in different states. He has countless hours of internet research in the field and has spoken on the technology at a railroad tie association meeting. Hundreds of profile samples have been produced and the results monitored and the formulation perfected. He has traveled to the country of Kuwait, by invitation from Mr. Badar Amade, an attorney/businessman. There are only a few people in this field of large profile production and his company's product was considered the best product in the industry. He also has significant experience in designing the molds for the extruded composite and has been involved in (1) installation of the test ties and (2) numerous strength and design tests. The undersigned hereby declares that such a background establishes him as one of ordinary skill in the pertinent art.

The undersigned hereby declares that the claimed subject matter has solved a problem that is long standing in the art; specifically, a railroad tie which utilizes recycled post consumer waste materials, which exhibits sufficient strength, stiffness, and flexibility and which meets federal safety requirements. The railroad tie claimed in the above patent application, a substantially trapezoidal railroad tie made of a composite of thermoplastic resin and a calcium sulfate composition, solves these problems.

The undersigned hereby declares that since approximately 1988, there has been a long-felt but unsolved need to replace existing chemically treated wood railroad cross-ties with recycled plastic lumber (See Exibit "1" Memorandum For Record dated 26 January 2001). It was not until the mid-1990's that those of ordinary skill in the art began research and development to solve the problem. (See Exhibit "2" Fact Sheet dated 13 February 2004).

The undersigned hereby declares upon information and belief that if those persons of ordinary skill in the art who were working on the problem knew of the teachings of the cited references, they would still be unable to solve the problem as it has been done by the above patent application. As explained in Exhibit "1", the different plastic compositions have different properties from one another (see Exhibit "1" at page 3). For example, concrete railroad cross ties as disclosed by Buekett U.S. Patent No. 4,925,094 exhibit sufficient strength, but not flexibility. Additionally, concrete railroad cross ties tend to wear at the rail-to-tie attachment (see Buekett, col. 1, lines 22-27). Plastic-fiberglass composite railroad cross ties as disclosed by Nosker U.S. Patent No. 5,916,932 exhibit inefficient stress transfer (see Exhibit "3" 2002 Nova Award Nomination 13, use of commercially available glass fibers was ineffective due to inefficient stress transfer). While HDPE offers both performance and environmental advantages, there are mechanical property limitations (See Exhibit "1" at page 3, Exhibit "2" at page 1).

The undersigned hereby declares that the railroad tie as claimed in the above patent application has been field tested and revealed unexpected and superior results (See Exhibit "4" letters from entities field testing railroad ties as claimed in the above patent application). The results achieved by the claimed railroad ties are greater than those which would have been expected from the prior art to an unobvious extent. Further, those results offer a significant, practical advantage (See Exhibit "4", letter from Union Pacific regarding trapezoidal shape).

The undersigned hereby declares that the railroad ties as claimed in the above patent application have resulted in commercial success as additional ties were purchased as a result of the exceptional performance (see Exhibit "5" letters for additional purchases as a result of performance). It was the unexpected performance of the railroad ties as claimed in the above patent application that was responsible for this commercial success.

The undersigned hereby declares that all statements made of his own knowledge are true and that all statements made on information and belief are believed to be true, and that this statement is made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

11-17-06 John C. Bayer

Date John C. Bayer

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Memorandum For Record 26 January 2001

Subject: An Estimate of the Effect on Greenhouse Gases by Using Recycled Plastic as a Substitute for Treated Wood Railroad Crossties

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Introduction

Background

Recycled-plastic lumber has been under development and in use in the United States at least since 1988, and considerable progress has been made in understanding and controlling its properties, and utilizing it in many traditional chemically treated wood applications. This progress has been helped significantly through the efforts of industry, government, and academia to develop ASTM test methods and standards for these materials. The fairly recent creation of structural types of plastic lumber (that is, with a higher elastic modulus [stiffness] compared to standard plastic lumber materials) have made possible the substitution of recycled-plastic lumber in many structural applications where wood is traditionally used. Examples include railroad (RR) crossties and substructures for decks, docks, and bridges. The substitution of recycled-plastic lumber for chemically treated wood in these applications has heretofore been made almost entirely on the basis of life-cycle costs. However, this study explores the possibility that compelling environmental issues could provide an even greater incentive for this material substitution.

An average of 10 to15 million wooden RR crossties are replaced in the United States every year. Each standard tie is roughly 17.8 x 22.9 x 259 cm (7 x 9 x 102 in.) and weighs approximately 90.7 kg (200 lb). To understand the real magnitude of the number of ties replaced each year, one may consider that 15 million standard railroad ties placed end-to-end would span a distance of nearly 38,600 kilometers (24,000 miles) -- almost the distance once around the earth. Considering that each tie is pressure-treated with several gallons of creosote (which is applied to provide resistance against biological attack), such a quantity of ties also represents millions of gallons of a hazardous chemical being introduced into the environment. If post-consumer recycled plastics could be used to fabricate a replacement for a chemically treated wood tie, it was envisioned that significant amounts of recycled plastics could be diverted from landfill, thus

EXHIBIT
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saving many trees from being cut down. In addition, the environment could be spared exposure to many gallons of chemical treatments. It was also thought that the use of recycled-plastic RR ties as a substitute for wood ties might also have a significant benefit regarding the buildup of greenhouse gases (GHG) and the related problem of global warming potential that now may be underway [1].

Objective

The objective of this effort was to estimate the expected positive effect on reducing greenhouse gases by using recycled plastic RR ties as a substitute for traditional treated wood RR crossties. This effort was supported by an Interagency Agreement, #DW96947934-01-0, dated 25 August 1999, between the U.S. Environmental Protection Agency (USEPA), Region 5, and the U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL). This Memorandum For Record documents the outcome of this study.

Approach

Greenhouse gas factors and calculation methodologies used in this report are taken from the USEPA report entitled "Greenhouse Gas Emissions From Management of Selected Materials in Municipal Solid Waste" [2]. It should be noted here that the GHG benefits could only be estimated based on the best fit of information currently available; possible deviations are noted herein. When more applicable data are developed, the approach presented here can serve as a guideline to more accurately calculate the GHG emissions. It should also be stated that this approach can be used for the analysis of GHG emissions when substituting plastic lumber in many other possible applications where wood is relatively short-lived, including decking, marine pilings, bridges, and even pallets. However, due caution is warranted insofar as several requirements must be met in order to assure that plastic lumber will last for a long time. Mechanical properties of materials and the related stresses of the application must be carefully considered; the design must take into account thermal expansion and fastening issues; and above all, if the material is to be used outside it must have properties that are not significantly affected by sunlight, moisture and temperature cycling. Plastic-lumber-type materials containing high levels of wood-based materials, for example, have been observed to degrade even more rapidly than chemically preserved wood under certain circumstances.

Plastic Railroad Crossties -- State Of The Art

A team made up of Conrail and Norfolk Southern railroads, Rutgers University, and the U.S. Army ERDC-CERL began in 1996 to develop a plastic composite crosstie specification [3] [4] [5]. The specification was based on Class 1 freight applications, which are considered to be the most demanding. This specification provided valuable guidance as to what the research targets would be in terms of product appearance and performance. The philosophy taken by the research team at that time was to develop a specification for a tie that could withstand the most demanding situation that a tie could be expected to endure -- for example, a tie on a mountain curve with heavy freight passing over the track. An alternative approach might have been to

develop multiple specifications for different loading conditions, but that approach was not taken because tracking different grades of plastic-based ties was deemed unfavorable.

The target tie was specified to have the general dimensions (17.8 x 22.9 x 259 cm [7 x 9 x 102 in.]) and appearance of a standard hardwood tie, and it would not absorb water, diesel fuel, mineral oil, or grease. The substitute tie would not be electrically conductive or highly susceptible to degradation from environmental exposures or abrasion. Also it would not increase its 143.5 cm (56.5 in.) gauge by more than 0.318 cm (0.125 in.) under a lateral load of 10,900 kg (24,000 lbf) and a static vertical load of 17,700 kg (39,000 lbf). The target tie would be required to sustain a dynamic vertical load of 63,500 kg (140,000 lbf). Installation of the substitute tie should be easily facilitated with standard materials-handling systems, utilizing standard premium fastening systems.

Non-Class 1 railroad systems would be expected to have different (lower) stress levels associated with their use. For example, a short line railroad might require the same static vertical loads but lower lateral loads and dynamic vertical loads because these ties are generally traversed at lower speeds. In a similar fashion, rapid transit systems would be expected to have much lower vertical loads (static and dynamic) but perhaps similar lateral forces produced by lighter trains traveling at higher speeds.

The base material used in nearly all of the currently marketed plastic RR ties is high-density polyethylene (HDPE). HDPE is moisture- and insect- proof but can slowly degrade by oxidation under the influence of ultraviolet (UV) radiation at a rate of up to 0.076 mm (0.003 in.) per year [6]. The properties of most composite plastic ties should, therefore, not deteriorate rapidly in the field. At least two of the currently available composite tie formulations contain at least 60% HDPE by weight. One manufacturer's composite tie, which contains fiberglass, has been shown to not lose any of its mechanical properties when exposed to cyclic moisture, temperature, and UV radiation at levels equivalent to 15 years of exposure for a wood tie. Another manufacturer's composite tie formulation containing HDPE and polystyrene achieved similar results when subjected to the same tests, and was also found to not lose any strength or stiffness after 11 years of outdoor exposure in New Jersey.

To date, at least six manufacturers have produced recycled-plastic based ties -- not all of which meet the previously noted target properties -- that have been installed in various quantities in active track within the United States. Some of these ties have been subjected to extreme accelerated service testing and have shown no signs of failure of any type. The composition of the different ties varies from glass-fiber-reinforced composites, to polymer-fiber-reinforced composites, to mineral-filled polymer composites, to a hybrid plastic, steel, and concrete composite. It is noteworthy that each of these material combinations will have different properties from one another, just as wood from different species of trees has different properties. Newer material combinations will undoubtedly be developed in future.

Depending on composition and quantity involved, plastic RR ties can cost any where from 1.5 to 3 times the amount for treated wood ties. In order to offset these higher initial costs relative to wood, the durability (that is, increased service life) of plastic composite ties must be factored in. If these ties are not able to provide significant increases in durability over traditional materials,

their market will be quite limited. Performance durability is also an important issue relative to the greenhouse gas benefits, as will be shown.

Based on the experience of the authors in this area, it is estimated that a recycled plastic composite railroad tie can be engineered to last at least 60 years in service in most, if not all applications, and 100 years of service is not out of the question in typical service exposures. Based on the above-mentioned UV degradation rate of HDPE, for example, a tie based on this material can be expected to lose less than 0.8 cm (less than one-third of an inch) of its 17.8 cm (7 in.) vertical thickness in 100 years. This represents less than a 5% loss in total cross-sectional area, with a corresponding loss in properties expected. Two plastic railroad tie manufacturers currently warrant their ties for 50 years and have laboratory test data showing essentially no degradation of properties in 12-15 year exposures. For ease of calculation we will use a 60-year plastic tie life to calculate the GHG benefit of utilizing recycled plastic ties.

Wood Railroad Crossties – State Of The Art

The overwhelming majority (93 %) of the approximately 15 million railroad crossties used per year in the United States are wood [7]. Class 1 railroads use predominantly hardwoods like oak, and short line railroads use mixed woods, including softwoods. Metropolitan transit systems use mixed woods (sometimes even exotic rainforest hardwoods) and concrete crossties. Wood ties are typically treated with creosote and (much less often) with chromated copper arsenate (CCA).

Wood tie failures occur most often as a result of one of two mechanisms – biological or mechanical. Biological attack causes tie failure most quickly in areas where the tie is subject to a combination of high moisture and high temperature. Mechanical modes of failure typically occur in tie locations where the highest dynamic lateral forces act on the ties. High dynamic lateral loads can, over time, cause the spike holes to elongate, with subsequent gauge widening or can cause abrasion and wear at the interface of the rail plate and the tie. These phenonina are commonly referred to as "spike killing" and "tie plate cutting," respectively. In severe exposures, these types of failures can occur in as little as 1 year. To mitigate spike killing, wooden plugs or other synthetic materials are typically inserted into the holes, and the ties are then respiked. This process can usually be done twice, leading to a 3-year life for ties in these most severe service conditions (such as on mountain curves, with heavy tonnage loads). To temporarily work around tie plate cutting, the tie can usually be flipped over and reused. However, once the reverse side also becomes worn, the tie must either be moved for use in low speed applications, such as in a yard, or discarded altogether.

On a straight section of track on the high plains of the United States, a wooden tie can last as long as 50 years. The Chicago Transit Authority and the Metropolitan Transit Agency (New York City) replace their wooden ties roughly every 25 years. Norfolk Southern Corporation replaces many of its ties that are in relatively wet locations in the Southeastern United States every 3 to 5 years. It is difficult to determine how many of the 15 million ties purchased every year go into applications with a short useful tie life, but it is reasonable to assume that a high percentage of the ties sold go into the shortest-lived applications simply because they get replaced much more often.

Greenhouse Gas Calculations

Estimates of the effect of using recycled plastic railroad crossties as a substitute for traditional wooden crossties are detailed below, using referenced numbers from the USEPA report, "Greenhouse Gas Emissions From Management of Selected Materials in Municipal Solid Waste" [2]. The calculations are to be considered as only an estimate because, for example, specific information on the role of hardwood lumber is not found in the referenced document.

In the USEPA document, the units that are pertinent to this comparison are the Metric Ton Carbon Equivalent (of gas) per short ton of (solid) material utilized, or MTCE/ton. In the following, the MTCE/ton "cost" of producing and using a recycled-plastic railroad tie is compared with the MTCE/ton "cost" of producing and using a wooden tie.

Plastic lumber, of which railroad ties is a subset, is typically molded or extruded using unwashed, granulated plastic bottles (predominantly HDPE) as a primary feedstock. The methods of plastic recycling for which data are available in the USEPA report are limited to resin recovery processes, which involve additional washing and extrusion/melt filtering steps. The plastic ties that have been under development in the United States to date are made predominantly from HDPE, with lower percentages of other polymers, and, in some instances, glass fibers or other mineral fillers. We will approximate the MTCE/ton cost for producing a recycled plastic railroad tie to be 0.28, as taken from Exhibit 2-2, column G of the referenced USEPA report. This value includes transportation and processing of recycled HDPE for resin recovery. This number is actually somewhat higher than it should be for plastic lumber production because it involves extra energy-intensive steps, but it is the best information currently available.

No value for the MTCE/ton cost of producing a wooden railroad tie is available in the USEPA report, but MTCE/ton information for the production of dimensional lumber was obtained directly from Mr. Henry Ferland of the USEPA [8]. The average combined process energy emissions, transportation energy emissions, and process non-energy emissions for dimensional lumber have a value of 0.02 MTCE/ton of product. For this estimate, the energy-intensive chemical preservative manufacture and tie treatment processes has not been accounted for. Therefore, while this value is an imperfect estimate, it is nonetheless the best information currently available.

An additional factor must be considered for items produced from wood. Wood comes from trees, which sequester carbon that they remove from the atmosphere. The MTCE/ton cost associated with forest carbon sequestration is 0.73, as taken from Exhibit 3-8 and discussed on page 54 of the USEPA report.

Summing up the above factors, the MTCE/ton benefit for producing a plastic crosstie as a replacement for a wooden tie is equal to the MTCE/ton costs associated with making a wooden tie minus the MTCE cost associated with producing a plastic tie, as follows:

$$(0.73 + 0.02) - 0.28 = 0.47 \text{ MTCE/ton}$$

The above calculation is only an estimate, but is considered to be close. This calculation represents the benefit if the plastic tie lasts only as long as a wooden tie. If a plastic tie outlasts a wooden tie, which it will in most cases, the benefit will be greater. For example, if it is assumed that a plastic tie will last 60 years (at least two of the manufacturers guarantee their ties for 50 years), the calculations are done as follows:

> For the replacement of a wooden tie in a situation where it typically lasts 30 years, MTCE/ton credit for a second wooden tie can be claimed upon installation of a plastic tie, or:
>
> $$2 \times (0.73 + 0.02) - 0.28 = 1.22 \text{ MTCE/ton}$$
>
> For the replacement of a wooden tie in a situation where it typically lasts 15 years, MTCE/ton credit for a second, third, and fourth wooden tie can be claimed upon installation of a plastic tie, or:
>
> $$4 \times (0.73 + 0.02) - 0.28 = 2.72 \text{ MTCE/ton}$$
>
> For the replacement of a wooden tie in a situation where it typically lasts just 5 years, MTCE/ton credit for a second, third, fourth, fifth, sixth,....and twelfth wooden tie can be claimed upon installation of a plastic tie, or:
>
> $$12 \times (0.73 + 0.02) - 0.28 = 8.72 \text{ MTCE/ton}$$
>
> For the replacement of a wooden tie in a situation where it typically lasts just 3 years, as in the most demanding service applications, MTCE/ton credit for a second, third, fourth, fifth, sixth,....and twentieth wooden tie can be claimed upon installation of a plastic tie, or:
>
> $$20 \times (0.73 + 0.02) - 0.28 = 14.72 \text{ MTCE/ton}$$

These are impressive numbers, especially in severe exposure applications where wood ties must be replaced often. The benefit of recycling aluminum (the current MTCE/ton leader of recycling) is about 3 MTCE/ton. This analysis does not include the MTCE associated with actual tie replacement. This number would be hard to estimate in a general sense because of site specific variables attributable to rerouting rail traffic over longer routes for tie maintenance and replacement. However, factoring in such a value would increase the MTCE/ton benefit of plastic

composite ties even further. As stated above, these numbers are only estimates, but the concept of substituting a long-lasting plastic item for wood to have a very significant effect on greenhouse gases is a durable principle. These results contradict the common perception that recycling plastic bottles back into bottles (closed-loop recycling) is more environmentally advantageous than producing plastic lumber from bottles (open-loop recycling).

Benefits of Plastic Lumber Applications

Recall that the above results are considered applicable to other plastic lumber applications. The argument for a longer-lasting substitute material for treated wood is expressed in the following quote:

> "Did you know? A full two-thirds of all wood decks replaced are less than 10 years old? More than half of these are replaced because they were rotting, infested with insects, or no longer structurally sound. Building with recycled-plastic lumber eliminates these problems. It also eliminates the need to dispose of the chemically-laden waste of pressure-treated lumber when dismantling that rotting deck. And, you don't have to worry about chemicals leaching from your deck as you relax on your recycled-plastic lumber deck. [9]."

To demonstrate GHG benefits in other applications similar to those estimated for using plastic RR ties, the plastic lumber structure must be designed for a long service life and take into account material properties such as strength, stiffness, creep under long-term loading, and differential thermal expansion [10] [11].

A plastic lumber bridge built at Fort Leonard Wood, MO, can be used to demonstrate the GHG benefits of plastic lumber structures [12] [13]. The original 7.9 meter (26 ft) wide by 7.3 meter (24 ft) long bridge was a wooden structure originally rated for light vehicular traffic, but it had been restricted to pedestrian traffic due to the highly deteriorated state of the wood. A replacement plastic lumber bridge structure was designed and constructed in June 1998. Like the original wooden bridge, the replacement plastic lumber bridge was designed for vehicular traffic. According to base engineering personnel, treated wood structures at Fort Leonard Wood have a life expectancy of 15 years with planned biannual maintenance. (Of course, the amount of maintenance and repair work conducted during this biannual schedule would increase over the years as the wood ages and deteriorates.) For the plastic lumber bridge, materials from four different manufacturers were used. Structural-grade plastic lumber was used for the substructure joists, side-railings, and railing slats, and standard-grade plastic lumber was used for the bridge decking and top railing. To date, this plastic lumber bridge looks like new with no evidence of deterioration or failure.

The materials costs for the plastic lumber materials needed to build this bridge were estimated to be about 2.5 times more compared to the cost of materials for the same bridge made from treated wood. However, given the very low maintenance requirements of the plastic lumber compared to wood, a life cycle cost analysis showed that the plastic lumber bridge would pay for itself in approximately 7.5 years.

As with the plastic RR ties, a 60-year service life is very likely and is used here for ease of the GHG calculations that follow. First, assuming the plastic lumber materials last only as long as treated wood, the MTCE for using plastic lumber as a replacement material for treated wood is the same for the bridge as for the plastic RR ties; that is:

$$(0.73 + 0.02) - 0.28 = 0.47 \text{ MTCE/ton}$$

At a 60-year life expectancy for the plastic lumber, but assuming an average 15-year replacement cycle for a treated wood structure, a wooden bridge would have to be replaced three more times to equal the service life of the original plastic lumber bridge. Considering future bridge replacements, a second, third, and fourth MTCE/ton can be credited, as follows:

$$4 \times (0.73 + 0.02) - 0.28 = 2.72 \text{ MTCE/ton}$$

Approximately 6.5 short tons (13,000 lb) of plastic lumber materials were used to construct the Fort Leonard Wood bridge. By using plastic lumber instead of treated wood to build this bridge, the total GHG benefit equals:

$$6.5 \times 2.72 = 17.68 \text{ MTCE}$$

Similar GHG benefits can be demonstrated for almost any plastic lumber structure. Of course, for these benefits to be fully realized, the structure must be designed properly to minimize system failures over the expected design life. The result also assumes the use of a plastic lumber material with no substantial content of rapidly degradable organic materials.

Conclusions

As demonstrated by the calculations developed in this study, the replacement of recycled-plastic lumber for chemically-treated wood can have a very significant positive effect on reducing greenhouse gases. The exact level of the greenhouse-beneficial effect depends on how frequently the traditional wooden item is typically replaced. Given the large number currently replaced each year, the benefit for replacing plastic RR ties for word RR ties would be significant at any reasonable level of market share. Interestingly in this case, the greatest greenhouse gas benefit occurs where the financial benefit of using a long-life material is also greatest. This finding is an encouraging departure from the many cases in which the most environmentally friendly option ends up being the most costly.

Recommendations

The results of this study suggest the following recommendations:

- MTCE factors for chemically treated wood and recycled, unwashed HDPE should be developed and the GHG benefits for plastic RR ties (and other related plastic lumber materials) recalculated in order to refine the existing numbers and improve their utility in

other analyses.

- The environmental benefits of using recycled-plastic RR ties (and other recycled-plastic lumber products) as brought out in this study should be well publicized and referenced in technical papers and other documents especially while stressing the benefits of decreasing GHGs and the penalties for increasing GHGs in the environment. Further acceptance of these benefits could lead to Federal, state and local initiatives and policy changes that would be not only environmentally sound but cost-effective as well.
- Industry and government should support increased research and development for all-plastic lumber outdoor structures (e.g., decks, docks, boardwalks, bridges) with the thought that increased substitution of plastic for wood in such structures would have a positive GHG benefit.
- Research, development, and testing efforts concerning recycled-plastic RR ties should continue as these products still need to gain increased acceptance by the railroad engineering community. Plastic ties have the potential to gain a significant piece of the replacement tie market share, but additional demonstrations will be needed to further demonstrate their performance, including economic and environmental benefits.

References

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FACT SHEET

U.S. Army ERDC-CERL
13 February 2004

SUBJECT: In-Track Performance Evaluations of Recycled-Plastic Composite Cross Ties

1. Background. Wood has been the traditional material used for railroad (RR) cross ties during the 150-plus years of railroading in the United States. Trains now carry up to 39 tons (35,400 kg) per axle versus 36 tons (32,650 kg) just a few years ago. In many cases this increased loading has accelerated the wear of wood ties. The resulting decrease in the service life of wood ties as well as growing environmental concerns about the use of creosote as a wood preservative have prompted industry interest in alternative RR cross tie materials.

2. Origins of the Plastic Tie Technology. In the early 1990s several manufacturers in the United States had the idea to produce RR ties made from recycled waste plastics. However, it was quickly learned that it takes more than just a cross tie-sized block of plastic to provide proper track performance. By the mid-1990s at least two independent groups were developing engineered plastic composite RR ties using recycled high-density polyethylene (HDPE) and incorporating reinforcement elements into the recycled-plastic matrix for property enhancements (Ref. a.). Despite its mechanical property limitations, HDPE offers both performance and environmental advantages for use as RR cross ties. Insects and other organisms can attack wood ties and shorten their service life, particularly in warm, moist soils. To fight insect attack and rot, wood ties must be chemically treated, usually with creosote. HDPE does not require such treatment because it is inherently resistant to insects and rot. Given that approximately 15 million cross ties are replaced each year by U.S. railroads, and considering the volume of plastic used to make each tie, it has been projected that considerable amounts of waste plastic could be diverted from landfills and put to beneficial use if plastic ties could achieve any significant market penetration.

3. Minimum Performance Requirements. In 1994, a group that included personnel from Rutgers University, Norfolk Southern Railroad, the former Conrail Railroad, the U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL), and a major plastic lumber manufacturer established preliminary performance targets for developing plastic RR ties suitable for Class 1 rail service. These targets were based not simply on the empirical properties of a wood tie as determined in a laboratory, but on the actual mechanical and physical property requirements for a cross tie functioning properly in service. In 2000, a Subcommittee on Engineered Composite Ties was established under the American Railway Engineering and Maintenance-of-Way Association (AREMA) Committee 30 on Cross Ties to develop recommended engineering standards and practice for the use of these new cross tie materials. These standards, which used the 1994 performance targets as a starting point, were first published in the 2003 Edition of the AREMA Manual for Railway Engineering. The standards represent a minimum performance specification for the use of plastic composite ties in Class 1, heavy-axle-load rail service (Ref. b.). The following table lists some of the recommended minimum performance requirements from the AREMA Manual for plastic composite cross ties.

EXHIBIT
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Table: Some Physical and Mechanical Properties for Plastic Composite RR Cross Ties

Modulus of Elasticity – MOE, psi (MPa)	Modulus of Rupture – MOR, psi (MPa)	Rail Seat Compression, psi (MPa)	Single Tie Lateral Push, lbf (kN)	Spike/Screw Pullout, lbf (kN)	Max. Coefficient of Thermal Expansion, in/in/°F (cm/cm/°C)
170,000 (1,170)	2,000 (13.8)	900 (6.2)	2,000 – 4,000 (8.9 – 17.8)	1,900/5,000 (8.5/22.2)	$7.5X10^{-5}$ ($1.35X10^{-4}$)

4. Types of Plastic Composite Ties. In little more than a decade since the first field tests, various manufacturers have entered the market with an assortment of plastic composite tie designs. Generically, these new plastic composite ties include such compositions as:

   - Glass-fiber reinforced HDPE matrix
   - Glass-fiber reinforced rubber-modified HDPE matrix
   - Immiscible polymer blend (IMPB) polystyrene (PS)-HDPE matrix
   - HDPE and mineral byproduct combination
   - Hybrid steel, concrete, and plastic composite design

   Variations on the above — and even entirely different compositions or design types — may be possible in the future as new manufacturers start competing for a share of the tie replacement market.

5. Field Testing.

   a. In April 1996, two plastic cross ties were installed in a 5-degree curve in the Facility for Accelerated Service Testing (FAST) at the Association of American Railroads (AAR) Transportation Technology Center, Inc. (TTCI), Pueblo, CO. After 130 million gross tons (MGT) (118 billion gross kg) of traffic at 40 mph (64 km/hr), one of the ties was removed for laboratory testing. This removed tie was subjected to a rail seat abrasion test to determine the sensitivity of the tie material to tie plate cutting. The testing machine broke down after 900,000 cycles with no evidence of tie plate cutting up to that point. Based on satisfactory performance of the originally installed ties, 24 additional plastic composite ties were installed in March 1997.

   b. Also during this general time frame, another manufacturer's composite tie formulation was tested at TTCI. It withstood 2,000,000 cycles with no plate cutting while exhibiting good holding power using cut spikes. Ties manufactured by additional companies have since been installed in the FAST. The specimens that have been in place the longest have now supported over 700 MGT (635 billion gross kg) of traffic with very good performance results to date.

c. One tie performance parameter that warrants special mention is lateral track stability. In lateral tie push-out tests performed on some plastic composite ties by TTCI, approximately 1,000 lbf (4.45 kN) was required to push out newly installed plastic ties. This value falls within the performance range typical for a newly installed wood cross tie of equivalent size. After 15 – 20 MGT (13.6 – 18 billion gross kg) of traffic, the hard rock ballast will begin to "lock" into the wood tie and the lateral push-out force will increase to around 2,500 – 3,000 lbf (11.1 – 13.3 kN). The push-out tests performed on the plastic ties after approximately 15 MGT (13.6 billion gross kg) returned a push-out value similar to the as-installed value. This result indicates that plastic composite ties are too hard and friction-resistant to achieve significant mechanical interlocking with the ballast.

d. In order to increase the tie-to-ballast interaction and consequently increase the lateral tie push-out resistance, manufacturers have heat-embossed textured patterns into the sides and bottom of ties. Norfolk Southern conducted field tests using some of these embossed ties during November 1997. The ties were installed, tamped, and ballasted in the same manner as a conventional wood tie. Even with no accumulated traffic, up to 4,500 lbf (20 kN) force was needed to push out the ties with the embossed pattern. Other tests of these embossed plastic composite ties conducted by the Army, TTCI, and various commercial railroads have demonstrated lateral stability values up to 50 percent greater than those for wood ties.

e. Although plastic ties exhibit much lower stiffness than wood ties as measured in flexure in the laboratory, some researchers believed that, because of the effects of loading rate on polymeric materials (i.e., effective stiffness rises in correlation with increases in loading rate), the plastic ties would demonstrate much more stiffness in track than laboratory results indicated. This idea was tested on a 100-tie section of plastic composite ties installed in a 6-degree, 5-inch superelevation curve on the High Tonnage Loop at the FAST. The total track modulus (stiffness) of this 100-tie section was measured and compared with an adjacent oak tie section. The vertical modulus was measured both statically and dynamically at two different temperatures (tie center at 33 °F [0.6 °C] and 121 °F [49.4 °C]). No difference in stiffness was found between plastic tie and wood tie track, and no significant change in stiffness was attributable to temperature in either type of tie. The vertical track modulus, in lbf/in./in. (kN/cm/cm) was 3190 – 3430 (14.2 – 15.3) for plastic-tie track and 3160 – 3240 (14.1 – 14.4) for wood-tie track (Ref. c.).

6. <u>Field Installations</u>.

a. Plastic composite ties are accumulating traffic not only at the Pueblo test center but also in revenue, mass transit, and military track applications. The Union Pacific (UP) Railroad has the largest number of plastic composite ties installed of any U.S. railroad, using mostly cut spikes (Fig. 1). In one UP installation carrying 263,000 lb (119,000 kg) coal cars, composite ties have accumulated 850 MGT (770 billion gross kg) since July 1998 with no indication of plate cutting or spike back-out. To date, the Chicago Transit Authority (CTA) has installed the largest number of plastic composite ties of any transit railroad. Over the years, the dripping of creosote from elevated track onto pedestrians

and property has been a problem for the CTA. The CTA looked to plastic ties as a way to eliminate dripping creosote as well as the problem of stray-current corrosion of track fasteners. After a successful trial using a small group of plastic ties at one of its elevated stations, the CTA decided to install plastic composite ties not only in its elevated (open) track but also in ballasted track to take advantage of the increased lateral stability. Performance has been successful enough that installation of tens of thousands of additional plastic ties is currently in progress (Fig. 2).

b. In December 1998, the U.S. Naval Surface Warfare Center (NSWC) in Crane, Indiana, installed a set of 64 recycled-plastic composite ties in an AREMA #10 turnout (Fig. 3). This installation was undertaken to demonstrate that plastic ties could perform well in a turnout under heavy axle load in light- to medium-density traffic service conditions. Several types of fasteners were used, including Pandrol™ plates and screw spikes as well as a hybrid of 5/8 in. (1.6 cm) lag screws and cut spikes in a standard cut spike tie plate. Since being placed into service, no component failures or major problems have occurred. A second plastic tie turnout was installed at NSWC in June 2002 using plastic ties from a different manufacturer. As a result of these successful NSWC installations, six switch sets using composite ties from three different manufacturers were installed on the Washington D.C. Metro commuter rail service (Fig. 4).

   In the Spring of 2003, several groups of plastic ties from three different manufacturers were installed in a curved section on one of the main lines at the Crane NSWC. Wood ties at this location have failed prematurely due to severe tie-plate cutting. The installed plastic composite ties did not show evidence of excessive tie-plate cutting, but they have not exhibited the stability that has come to be expected. Track wandering and large deflections have been observed even after tamping the ballast on several occasions. An inspection in September 2003 indicated that the problem probably is not related to the tie material but rather to instability in the sub-ballast, which was disturbed during the installation of the new ties. Onsite cone penetrometer tests are planned for Spring 2004 to verify this hypothesis.

7. <u>Status of the Technology</u>. The plastic composite ties installed at the Crane NSWC as well as those at the mass transit and Class 1 railroads discussed here will continue to be monitored for several years to help establish a long-term performance history. Research will also continue for the purpose of assessing performance predictions and safety issues (Ref. d.). Recycled-plastic composite cross ties are scheduled for installation in track at Fort Campbell, KY, as part of an environmental sustainability program demonstration in Spring 2004. The ties will be installed in locations where wood ties have had performance problems — mainly in damp locations. Knowledge gained as a result of all of these continued activities will be applied to future revisions of the Engineered Composite Ties Section of the AREMA Railway Engineering Manual. Cross-references to AREMA Section 5 are being incorporated into Unified Facilities Guide Specifications (UFGS) used by the Army (UFGS 05650A, "Railroads") and Navy (UFGS 05650N, "Railroad Track and Accessories"). When incorporated, these cross-references to AREMA Section 5 will make it easier to specify composite plastic railroad ties and will help to support appropriate application.

8. References.

a. Lampo, R., T. Pinnick, and T. Nosker, "Development, Testing, and Demonstration of Recycled-Plastic Composite RR Cross Ties," proceedings of DoD-sponsored *Transportation 2000 Conference*, San Antonio, Texas, February – March 2000.

b. Chapter 30, Section 5, "Engineered Composite Ties," *Manual for Railway Engineering, 2003 Edition*, American Railway Engineering and Maintenance-of-Way Association, Maryland, April 2003. (The 2004 Edition will be published in April 2004.)

c. "Vertical Track Modulus in Plastic Composite Tie Test Zones at FAST," DOT/FRA/ORD-03/13, Federal Railroad Administration, Office of Research and Development, Washington D.C., January 2003.

d. Lampo, R., T. Nosker, and H. Sullivan, "Development, Testing, and Applications of Recycled Plastic Composite Cross Ties," proceedings of 2003 World Congress on Railway Research, Edinburgh, Scotland, September 2003.

Figure 1. Plastic-composite ties being installed by the UP on a bridge structure.

Figure 2. Plastic-composite ties installed in CTA's elevated track.

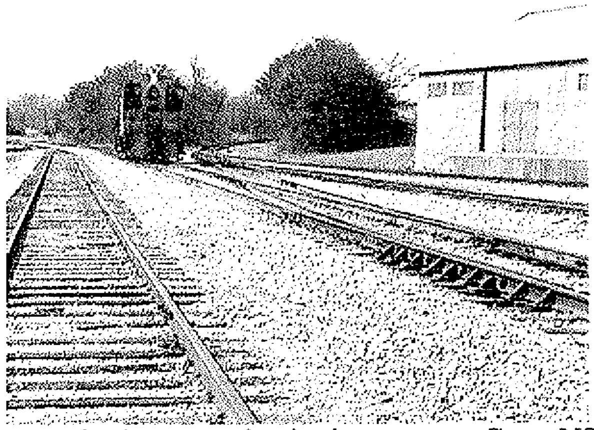

Figure 3. Plastic-composite ties in turnout at Crane NSWC.

Figure 4. Plastic tie turnout at Washington DC Metro's new yard facility.

Richard G. Lampo
217-373-6765 (voice); 217-373-6732 (fax)
Richard.G.Lampo@erdc.usace.army.mil

RECYCLED-PLASTIC COMPOSITE RAILROAD CROSSTIES

U.S. railroads replace about 15 million wood crossties each year, and increasing wheel loads are accelerating this deterioration every year. Environmental restrictions on preservative chemical treatments plus higher costs and lower durability have the railroad community interested in alternative materials to wood. Every year over 7 billion lb of high-density polyethylene (HDPE) plastic is molded into consumer product containers, and the vast majority of it ends up in landfills. In the early 1990s, the emerging U.S. plastics recycling industry began experimenting with the idea of fabricating plastic RR ties, and it was quickly determined that it takes more than a tie-shaped block of plastic to duplicate the service performance of a standard RR tie. Plastic ties would have inherent resistance to rot and insects, eliminating the need for chemical treatments, but recycled HDPE by itself lacked the required mechanical properties of wood.

In 1994, researchers from the U.S. Army Construction Engineering Research Laboratory (CERL), Rutgers University, U.S. Plastic Lumber (USPL), Polywood, Inc., and Conrail and Norfolk Southern railroads developed, demonstrated, and patented innovative recycled-plastic composite technologies for use as railroad crossties. First the researchers had to determine which physical and mechanical properties are required to achieve the desired in-service performance, and then they attempted to meet those requirements by incorporating reinforcement fibers into the HDPE to create a composite material. The use of commercially available glass-fibers as a reinforcement is a difficult approach because the high viscosity of molten HDPE results in poor wetting of the glass by the matrix polymer. The resulting fiber-impregnated material is ineffective due to inefficient stress transfer between the matrix and the reinforcement fibers; unwetted pockets of glass fibers act as gross material defects rather than reinforcements. These problems were overcome by either of two innovative techniques: the use of (1) chopped glass fibers recovered from scrap fiber-reinforced polymer composites and (2) recycled waste polystyrene. Using these reinforcements, elastic moduli exceeding 250,000 psi were achieved, compared to an average 90,000 psi for unreinforced recycled HDPE.

Field test installations were conducted by Conrail and Norfolk Southern, including a track section in Conrail's main line between Pittsburgh and Philadelphia. In a related effort, several groups of plastic composite ties were installed in the Facility for Accelerated Service Testing (FAST), a railroad industry test bed at Pueblo, CO; the purpose was to investigate various performance parameters, rail fastening hardware alternatives, and lateral track stability. The oldest ties have so far been subjected to over 500 million gross tons of traffic at heavy wheel loading; there have been no failures of the plastic composite ties, and none show signs of degradation or wear. In December 1998, recycled-plastic composite ties were installed in a turnout (switch) in mainline track at a military munitions center in Indiana — the first application of plastic ties in a turnout.

The longer life expectancy of the plastic ties makes them ideal for hard-to-maintain areas such as turnouts, bridges, and tunnels. USPL is now a licensed manufacturer of recycled-plastic composite RR ties, marketed under the name Duratie, using the Rutgers-developed innovative glass-fiber-reinforced recycled-HDPE technology. The innovative polystyrene reinforcement technology is now being licensed to Polywood, Inc., to manufacture recycled-plastic composite plastic RR ties. After a successful initial test in elevated commuter track, the Chicago Transit Authority has purchased more than 30,000 ties in open bid, and has installed these ties in both elevated and ballasted track. These two types of innovative reinforced plastics technology are now used both in mainline and transit tracks across the U.S., including the Washington D.C. and New York City mass transit authorities. The railroad industry's rapidly growing interest in these plastic composite ties has spurred several other composites manufacturers to compete for a share of the wood replacement tie market. Industry interest has also prompted the American Railway Engineering and Maintenance-of-Way Association (AREMA) to establish a new Subcommittee on Engineered Composite Ties, the purpose of which is to develop engineering guidance for the performance specifications and use of these tie technologies.

As recycled-plastic composite ties become common components in our nation's railroads, they will conserve millions of trees, reduce the leaching of hazardous wood tie preservative chemicals into the environment, and put substantial amounts of the nation's trash to constructive commercial use (thus conserving landfill space). Not insignificantly, these materials will also reduce the railroad industry's track maintenance costs. The rapid acceptance of these innovative composite crossties is especially remarkable considering the traditional and conservative nature of the railroad civil engineering community.

Still more benefits are likely to accrue to the nation from this technological development. Results of a recent study indicate that use of these recycled-plastic materials could help to reduce greenhouse gases in the atmosphere. Furthermore, this same technology could readily be adopted as a very low-cost, high-performance alternative to the more costly composites being tested in the public infrastructure today.

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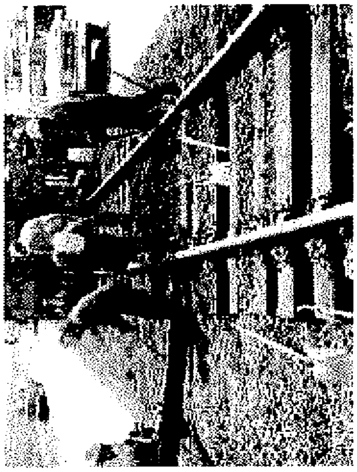
EXHIBIT
tabbies
3

RECYCLED-PLASTIC COMPOSITE RAILROAD CROSSTIES

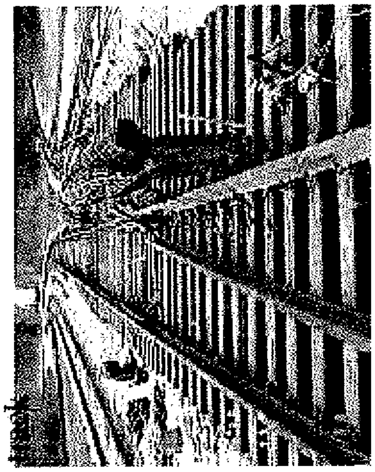

Rotting wood crossties


Waste plastics going to landfill


Recycled-plastic ties into test track

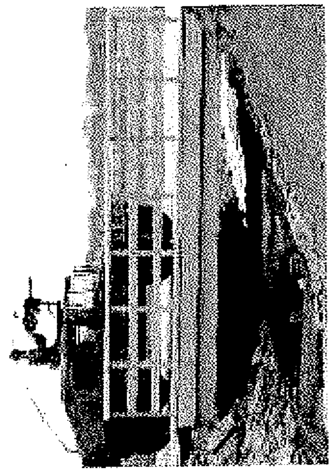

Taking performance measurements


Eng'd for increased lateral stability


Plastic composite ties in turnout


CTA installs plastic composite ties


Composite Ties Workshop 2001


Structural plastic lumber in bridge

BIGHORN DIVIDE & WYOMING
RAILROAD INC.

July 28, 2006

PolySum Technologies
Attn: John Bayer
P.O. Box 84051
Baton Rouge, LA 70084

John,

In reference to the Tuff Ties we installed in the Spring of 2000, they have had over 6.5 million tons of product carried over them and they are performing exceptionally well for us. There has been no spike creep or plate movement evidence in the soda ash load out or the acid load out. There is no evidence of deterioration at all.

If you need additional information, please call and we will do everything we can to assist you.

Sincerely,

Ed "Oscar" Kelsey
Vice President
Bighorn Divide and Wyoming Railroad

EXHIBIT
4

BDW • 642 South Federal Blvd. • Riverton, WY 82501 • (307) 856-7480 • Fax (307) 856-4623

June 9, 2000

PolySum Technologies, LLC
John C. Bayer
521 Rienzi
La Place, Louisiana 70068-3515

Dear John,

The plastic ties were installed on February 3, 2000. They were placed in or near the load out shed where they were subjected to large amounts of soda ash and limited amounts of sun and other weather conditions. Prior to the original installation, the ties were inspected for size, configuration and ease of handling. This inspection brought several things to light.

The configuration of the plastic ties required a modification of the surface. The first 24 inches would have to be flattened to allow for the tie plates to lay flat. This modification was accomplished with a small band saw mill. The ties were milled in 24 inches on each side.

Moving and spiking of the ties was the next step in the installation. Each of the ties required 2 men to move into place because of the tie's weight. Spiking the ties down posed another challenge. Using 5/8" x 5/8" x 6" spikes, we originally tried an air spiker without a pilot hole. This process was completely unsuccessful.

Our next spiking attempt called for drilling a 7/16" pilot hole. Using the spike driver, we successfully drove the spike in with high resistance. We believe it was more difficult than driving a spike into an oak tie with pilot holes. One item to note was the extreme resistance in the first 4 inches with the last 2 inches being relatively easy to drive. At this point we have not tried to remove a spike and reinstall it.

Since installation, we have run an average of 34 soda ash cars over the ties twice, once as empties and once as loads. This converts to an average tonnage of 5600 tons per day for approximately 127 days. We also have sent an average of 8 sulfur cars and 3 miscellaneous cars (i.e., sand, lime, and nitrate) across these ties twice per day, once as loads and once as empties. This converts to an additional 1803 tons per day. This is an overall average of 7403 tons per day.

All of the original plastic ties are still in place and are performing very well. We have not seen any evidence of spike movement in any of these ties.

The next test group of ties will be placed in #4 track. This is a track with very heavy traffic and some soft spots in the ground.

Sincerely,

Ed "Oscar" Kelsey
Site Superintendent

BTI • 642 South Federal Blvd. • Riverton, WY 82501 • (307) 856-7480 • Fax (307) 856-4623

BTI

August 27, 2003

PolySum Technologies
Attn: John Bayer
P.O. Box 84051
Baton Rouge, LA 70884

Mr. Bayer,

As per our conversation, I am writing this letter concerning TUFF TIES. We installed the ties at our facility over three years ago. At this time, we estimate over 3 million tons of product have gone across these ties. There is no evidence of plate or spike movement. There is no evidence of the ties splitting or deteriorating.

At this point in time, we are satisfied with the performance of your composite ties.

Sincerely,

Ed "Oscar" Kelsey
Assistance Vice
President BTI/BDW

BTI, 642 South Federal Blvd. * Riverton, WY 82501 * (307) 856-7480 Fax (307) 856-4623

NEW ORLEANS PUBLIC BELT RAILROAD
4822 TCHOUPITOULAS ST.
NEW ORLEANS, LA 70115
We care about safety, because we care about you!

J. BRIDGER
GENERAL MANAGER
896-7410

(504) 896-7400
(800) 524-3421
FAX NO. (504) 896-7452

J. MORROW
MANAGER, ADMINISTRATIVE
SERVICES & CLAIMS
896-7430

A. C. MARINELLO, JR.
MANAGER, ENGINEERING
AND MAINTENANCE
896-7420

T. LOBELLO
GENERAL SUPT.
896-7411

May 30, 2003

Mr. John C. Bayer, Manager
Poly Sum Technologies, L.L.C.
P.O. Box 84051
Baton Rouge, LA 70884

RE: Thermoplastic Railroad Ties

Dear Sir:

This is to confirm that the New Orleans Public Belt Railroad accepted delivery of twenty-five (25) 8" X 12" X 8'6" ties from your company on April 5, 2001. Shortly thereafter we installed them in Main Switch Lead Track applications. After over eighteen (18) months in service and over five (5) million gross tons of traffic the ties continue to perform effectively as to durability regarding spike hold down and the absence of tie plate cutting.

Thank you for allowing the New Orleans Public Belt Railroad the opportunity to field test your product.

If there should be any questions, please call me at 896-7420.

Sincerely,

Anthony C. Marinello, Jr.
Manager, Engineering & Maintenance

Microsoft Word - s:/engr/users/letters/Bayer 053003.doc

W. E. (Bill) WIMMER
Vice President-Engineering
Room 1030
(402) 271-4345

J. C. (Craig) DOMSKI
Chief Engineer-Track Programs
Room 1000
(402) 271-6153

T. T. (Tom) OGEE
Chief Engineer-Design
Room 1030
(402) 271-4946

D. L. (Darrel) DETERDING
Chief Engineer-Construction
Room 1030
(402) 271-5237

P.M. (Phil) ABARAY
Chief Engineer-Signals
Room 1000
(402) 271-3036

September 7, 2003

Mr. John Bayer
Polysum Technologies
P.O. Box 84051
Baton Rouge, La 70884

Dear Mr. Bayer,

As you know, Union Pacific Railroad has made the largest commitment to plastic composite ties than any other Class 1 US railroad. We believe that alternatives to wood that can be conventionally fastened (spikes) is becoming more of a requirement each day and therefore has become part of the UP's overall tie replacement strategy in high decay applications of our railroad. UP is interested in a broader supply base for plastic composite ties as the current base with fully developed products is insufficient to meet UP's demands much less the industry's. UP has demand for 150,000 to 200,000 ties next year, up from 75,000 this year. Our overall wood tie demand exceeds 4,000,000 ties.

Other than our current supplier, Polysum is the only plastic composite tie that has been approved for installation by UP's RTW group. Ed Kohake of UP's Research Testing and Welding group recently inspected both installations of the Polysum ties installed in our main tracks near Avondale, Louisiana. The ties installed in both locations were performing well. The properties you furnished from the early lab test of the Polysum ties are attractive and do appear to exceed some of those of our current approved product. These properties allowed us to approve the installation of the test ties near Avondale. We do encourage you to arrange for complete testing of full-scale ties at University of Illinois as soon as possible.

The trapezoidal shape of your heavy axle load is interesting and could ultimately reduce the numbers of ties required to adequately support the rail.

UP continues to search for alternatives to wood ties for certain applications. Although I receive numerous calls each month from prospective suppliers of composite ties, most of these do not understand the railroad environment or have unrealistic pricing structures. If the Polysum tie continues to perform well, lab testing confirms the initial results and the price is attractive, UP Engineering would show much interest in the Polysum tie for future installations.

I have copied both Mr. Tom Homes and Mr. Gary Hunter from UP's Supply department. Please keep UP informed as your business development continues.

Regards,

David A Connell
General Director-Engineering Technology
Union Pacific Railroad
402-271-5688
EMail; DCONNELL@up.com

c:
Tom Holmes
Gary Hunter
Russell Lloyd
Ed Kohake

June 23, 2003

Mr. John C. Bayer
Poly Sum Technologies, ILC.
P.O. Box 84051
Baton Rouge, Louisiana 70810

Dear Sir or Madam:

On behalf of the Regional Transit Authority, we would like to express our appreciation for the opportunity to have the track maintenance department work for the past two years with Poly-Sum Technologies. The Installation and Inspection Program of your Proto-Type Tuff-Tie have proven to meet RTA's expectations. My Observation during these past two years has clearly indicated the commitment and support of Poly-Sum Technologies to find a permanent solution to the St. Charles and Riverfront Crosstie replacement program. The installation of 33 Thermoplastic Railroad Ties on the Riverfront Streetcar Line were installed in a curve area near the Dumaine Streetcar stop area # 3. They were installed on 11/3/2000. From the week of installation to the present date RTA and Poly-Sum Technologies have maintained a log on the condition of these ties and roadbed. We have observed and inspected these ties performance, and the record shows no deterioration, no movement and the rail fasteners have remained in place. Also on our historical St. Charles Streetcar Line, the roadbed area is buried underground and only the ball of the rail is exposed. We purchased some 43 additional Thermoplastic ties. They were installed at a location on the St. Charles Line from Bordeaux to Valence Street on the inbound track. We have expressed great concerns about whether the Tuff- Ties would sustain this unique application of being under the ground to endure constant dampness from water and the temperature changes of the southeast Louisiana climate. The installation of 43 Thermoplastic Railroad Ties were on 5/26/2001. From the week of installation to the present date, the tracks have maintained good alignment and gauge in this area. Clearly the last two years these ties have performed well, meeting our expectations.

I would like to express my appreciation to you for the opportunity to have worked with you. Your professionalism has proven your continued commitment to finding a suitable crosstie for the unique application here in New Orleans and supporting the Regional Transit Authority's Crosstie Replacement Program.

Sincerely,

Earl Porter Jr.
Assistance Superintendent of Track & Maintenance Department

cc: Will Mullet
Eddy Moore

Regional
Transit
Authority

6700 Plaza Drive,
New Orleans,
Louisiana
70127-2677

Administration
504-242-2600
Facsimile
504-248-3637

EXHIBIT
5

BAD WATER LINE 642 S. Federal Blvd. Riverton, WY 82501 307-856-7480

September 19, 2000

John Bayer
Managing Member
Poly Sum Technologies
521 Rienzi
La Place, LA 70068

Dear John:

Following up my email, let this letter serve as a purchase order for 150 cross ties from your new plant @ $55/tie. It is also my understanding that these ties are within the specifications of the composite (gypsum and recycled plastic) ties we currently have in service.

Ties we have in place are performing admirably under severe heat/cold and show no degrading from the alkaline.

Good luck with your new plant.

Sincerely,

Cliff Root

Cliff Root
President

CT/ts